Comparative Analysis of Static and Dynamic Behaviour of Neurons in Artificial Neural Network

A Synopsis

Submitted in

Partial fulfillment for the degree

of

Doctor of Philosophy

(Computer Science)

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August, 2012

Introduction

Neurons behaviours using both static and dynamic conventional and neural network systems is the development of a mathematical calculation of a static and dynamic based on empirical data. Choice of neurons structure is based on well-established results in linear systems theory and can be applied in the development of non-linear neural networks identifiers with great success. This is the basis of neural network system identification solutions and the technique applied in the anti-lock braking system identification model. Before neural network system identification and its merits are examined, artificial neural networks and their concepts will be described. The background and concepts behind artificial neural networks is discussed along with the development of these simple structures into more complex recurrent neural networks.

An artificial neural network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing neurons working in unison to solve specific problems. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons.

Artificial neural networks (ANN) can be likened to collections of identical mathematical models that emulate some of the observed properties of biological nervous systems and draw on the analogies of adaptive biological learning. The key element of an Artificial Neural Network is its structure. It is composed of a number of interconnected processing elements tied together with weighted connections, which take inspiration from biological neurons.

It traces the growth of neural networks from their humble beginnings as single-layer perceptrons to neural network models. Both multi-layer and recurrent networks models are examined and their merits as behaviour. The system chosen as a basis for the empirical data collection is the anti-lock brake system, which exhibits highly non-linear behavior and lends itself to neural network modeling for system identification purposes. The back-propagation algorithm is used in the development of the neural network. Until recently, back-propagation neural networks made up 80% of all neural network applications. The use of back-propagation has declined due to the

relatively long required training times for the iterative algorithm. Genetic algorithms are discussed as a possible alternative.

Artificial neural network have grown up on the premise that the massively parallel distributed processing and connection is structure observed in the brain is the key behind its superior performance. By incorporating these features in the design of a new class of computer architectures and algorithms, it is hoped that, machines will exhibit human-like ability in handling real-world situations. Artificial neural network comprise a large number of threshold activated elements connected to each other.

A neural network is parameterized by its connection topology, characteristics of the threshold elements, and the learning rules for computing the connection weights between the elements. The conventional neural network paradigm has centered around the ``fixed-point" approach, where, the dynamics involves gradient descent of the network state to stable fixed-points (or, attractors of period 0) corresponding to desired patterns. However, human memory is an extremely dynamic phenomenon.

Objectives

The present work is undertaken to comparative analysis of static and dynamic behaviour of neurons in ANN with the following objectives:

- To Artificial Neural Networks (ANN) can be likened to collections of identical mathematical calculation.
- To comparative analysis of static behaviour of neurons with ANN.
- To comparative analysis of dynamic behaviour of neurons with ANN.
- To emulates some of the observed properties of biological nervous systems and draw on the analogies of adaptive biological learning.
- To analysis of key element of an Artificial Neural Network with structure.

Review of Literature

Thorough research over the four problem areas revealed a plethora of resources, some of which were entirely relevant, some though, ANN News were highly speculative and unsubstantiated. A balanced and substantiated review was thus carried out on papers, web resources and books relevant to, the reviews the research efforts in comparative analysis of static and dynamic behaviour of neurons.

1. Artificial Neural Networks
2. Comparative Analysis of Static and Dynamic Behaviour
3. Artificial neural networks approach
4. Genetic algorithm

1. Artificial Neural Networks

Artificial neural network applications have recently received considerable attention. The methodology of modeling, or estimation, is somewhat comparable to statistical modeling (Smith, 1993). Neural networks should not, however, be heralded as a substitute for statistical modeling, but rather as a complementary effort (without the restrictive assumption of a particular statistical model) or an alternative approach to fitting non-linear data.

There also exist few papers published on the neural network. The majority of those published have been produced by artificial neural network Researchers or academics that have used certain topics about this neural network for their synopsis or presentation at various neural network research articles.

Chongfu Huang, Claudio Moraga, 2004. Research articles on, a diffusion-neural-network for learning from small samples. In this, neural information processing models largely assume that the patterns for training a neural network are sufficient. Otherwise, there must exist a non-negligible error between the real function and the estimated function from a trained network. To reduce the error, in this paper, we suggest a diffusion-neural-network (DNN) to learn from a small sample consisting of only a few patterns. A DNN with more nodes in the input and layers is trained by using the deriving patterns instead of original patterns.

Guang-Bin Huang, 2005, work on, a generalized growing and pruning RBF (GGAP-RBF) neural network for function approximation. In this, this work presents a new sequential learning algorithm for radial basis function (RBF) networks referred to as generalized growing and pruning algorithm for RBF (GGAP-RBF). The paper first introduces the concept of significance for the hidden neurons and then uses it in the learning algorithm to realize parsimonious networks. The growing and pruning strategy of GGAP-RBF is based on linking the required learning accuracy with the significance of the nearest or intentionally added new neuron.

Jinn-Tsong Tsai, 2006, research paper, Tuning the structure and parameters of a neural network by using hybrid Taguchi-genetic algorithm, In this, a hybrid Taguchi-genetic algorithm (HTGA) is applied to solve the problem of tuning both network structure and parameters of a feed forward neural network. The HTGA approach is a method of combining the traditional genetic algorithm (TGA), which has a powerful global exploration capability, with the Taguchi method, which can exploit the optimum offspring.

Himavathi, S., 2007, research paper, feed forward Neural Network Implementation in FPGA Using Layer Multiplexing for Effective Resource Utilization. In this, presents a hardware implementation of multilayer feed forward neural networks (NN) using reconfigurable field-programmable gate arrays (FPGAs). Despite improvements in FPGA densities, the numerous multipliers in an NN limit the size of the network that can be implemented using a single FPGA, thus making NN applications not viable commercially.

Michael D. Richard, Richard P. Lippmann, 2008, research articles, Neural Network Classifiers Estimate Bayesian a posteriori Probabilities research articles, in this many neural network classifiers provide outputs which estimate Bayesian a posteriori probabilities. When the estimation is accurate, network outputs can be treated as probabilities and sum to one.

Wilamowski, B.M. ,2009, research paper, Neural network architectures and learning algorithms, research paper, In this, paper neural networks are very powerful as nonlinear signal processors, but obtained results are often far from satisfactory. The purpose of this paper is to evaluate the reasons for these frustrations and show how to make these neural networks successful. The following are the main challenges of neural network applications: (1) which neural network architectures should be used? (2) How large should a neural network be? (3) Which learning

algorithms are most suitable? The multilayer perceptron (MLP) architecture is unfortunately the preferred neural network topology of most researchers.

Francesco Galluppi, Alexander Rast, 2010, Research Articles, A General-Purpose Model Translation System for a Universal Neural Chip, in this, describes how an emerging standard neural network modeling language can be used to configure a general-purpose neural multi-chip system by describing the process of writing and loading neural network models on the SpiNNaker neuromimetic hardware. It focuses on the implementation of a SpiNNaker module for PyNN, a simulator- poor independent language for neural networks modeling.

Qiao Jiangang, 2011, research paper, Study on the prediction model of regional freight logistics based on BP neural network, in this, the prediction of regional freight logistics plays a vital role in the planning programming of Regional Logistics Information Platform. However, due to the incomplete existing data, the use of general prediction method will lead to large errors.

Eva Kaslik, 2011, research article, Impulsive hybrid discrete-time Hopfield neural networks with delays and multi stability analysis, In this paper we investigate multi stability of discrete-time Hopfield-type neural networks with distributed delays and impulses, by using Lyapunov functional, stability theory and control by impulses. Example and simulation results are given to illustrate the effective less of the results.

Della Chiesa, Andrea Boyle, 2011, research articles, Development of artificial neuronal networks for molecular communication, in this, Communication at the nano-scale can enhance capabilities for nano-devices, and at the same time open new opportunities for numerous healthcare applications. One approach towards enabling communication between nano-devices is through molecular communications. While a number of solutions have been proposed for molecular communication.

Anant Bhaskar Garg, Parag Diwan, 2012, research paper, Artificial Neural Networks based Methodologies for Optimization of Engine Operations, In this paper presents overview of applications of artificial neural networks (ANN) in the field of engine development. Various approaches using ANN are highlighted that resulted in better modeling of engine operations. Using ANN we can reduce engine development time. The paper discusses ANN approach, algorithms and importance of architecture.

Haza Nuzly Abdull Hamed, Nikola Kasabov, 2012, research paper, Dynamic Quantum-Inspired Particle Swarm Optimization as Feature and Parameter Optimizer for Evolving Spiking Neural Networks, In this, paper proposes a new structure for Quantum-inspired Particle Swarm Optimization (QiPSO) to enhance feature and parameter optimization of Evolving Spiking Neural Networks (ESNN). The new Dynamic Quantum-inspired Particle Swarm Optimization (DQiPSO) will be integrated within ESNN where features and parameters are simultaneously and more efficiently optimized.

2. Comparative Analysis of Static and Dynamic Behaviour

Neuron behaviour concerns with the determination of a system, on the basis of input output data samples. The behaviour task is to determine a suitable estimate of finite dimensional parameters which completely characterize of neurons. The selection of the estimate is based on comparison between the actual output sample and a predicted value on the basis of input data up to that instant. An adaptive automaton is a system whose structure is alterable or adjustable in such a way that its behavior or performance improves through contact with its environment. Depending upon input-output relation, the identification of systems can have two groups.

A. Static Behaviour

In this type of behaviour the output at any instant depends upon the input at that instant. These systems are described by the algebraic equations.

B. Dynamic Behaviour

In this type of behaviour the output at any instant depends upon the input at that instant as well as the past inputs and outputs. Dynamic behaviour is described by the difference or differential equations.

Bhama and Singh, research paper on Single layer neural network for linear system identification using gradient descent technique is reported. Narendra and Parthasarathy. The problem of nonlinear dynamical system identification using MLP structure trained by Back Propagation algorithm.

Chen and Billings have reported nonlinear system modeling and identification using ANN structures. They have studied this problem using an MLP structure and a radial basis function network and have obtained satisfactory results with networks.

Several research works have been reported on system identification using MLP networks in and using RBF networks. **Recently, Yang and Tseng** has reported function approximation with an orthonormal ANN using Legendre functions. Besides system identification, FLANN is used in some digital communication problems.

3. Artificial neural networks approach

Over the last few years, artificial intelligence techniques like neural networks are being used in the place of traditional regression methods for developing various travel demand forecasting models. Neural networks are capable of learning from examples, generalizing the knowledge learnt and apply to new data, and above all they are able to capture complex relationships in a relatively easier way than other computational methods. Over the last few years, artificial intelligence techniques like neural networks are being used in the place of traditional regression methods for developing various travel demand forecasting models. Neural networks are capable of learning from examples, generalizing the knowledge learnt and apply to new data, and above all they are able to capture complex relationships in a relatively easier way than other computational methods. Among other authors, neural networks have been used in the transportation demand forecasting by Chin et al (1992), Teodorović and Vukadinovic (1998), and forecasting intercity flows by Nijkamp et al (1996). Conceptually, feed forward neural networks approximate unknown functions to a good level of accuracy, i.e., they can be considered as “universal approximators”. The theorem proved by Hornik et al (1989) and Cybenko (1989) states that a multilayered feed-forward neural network with one hidden layer can approximate any continuous function up to a desired degree of accuracy provided it contains a sufficient number of nodes in the hidden layer.

4. Genetic Algorithm

The second major area of AI treated here is Genetic Algorithm (GA). This is a search algorithm based on the mechanics of natural selection and natural genetics. Genetic algorithm is an important and growing part of the artificial intelligence literature with numerous research findings. A good example of such studies could be found in Turney (1995). The study introduces ICET, a new algorithm for cost-sensitivity classification. ICET uses a genetic algorithm to evolve a population of biases for a decision tree induction algorithm. ICET is compared here with three other algorithms for cost-sensitive classification - EG2, CS-ID3, and IDX- and also with C4.5, which classifies without regard to cost.

Leung, F.H.F. ,2003, research paper, Tuning of the structure and parameters of a neural network using an improved genetic algorithm, In this, presents the tuning of the structure and parameters of a neural network using an improved genetic algorithm (GA). It will also be shown that the improved GA performs better than the standard GA based on some benchmark test functions. A neural network with switches introduced to its links is proposed. By doing this, the proposed neural network cannot learn both the input–output relationships of an application and the network structure using the improved GA.

Methodology

This research deals with the methodological steps adopted in the research study. The research procedures followed are described under the following headlines:

- **A.** Selection of abstract neurons
- **B.** Selection of abstract neurons sample
- **C.** Use of Tools and Techniques in research study
- **D.** Behaviour of neurons will be examined
- **E.** Comparative analysis
- **F.** Implementation in ANN

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